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Presentation of a Valuation Model for New Industrial Projects in the Automotive Industry

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Abstract

The aim of this research is to present a model for valuing new industrial projects in Iran's automotive industry. In this regard, a mixed-methods approach (qualitative and quantitative) was utilized. The qualitative part of the research employed grounded theory and involved interviews with 15 professors, experts, and specialists in the fields of valuation and automotive industry, using purposeful sampling to design the conceptual model of the research. In the next phase (the quantitative phase of the research), a fuzzy Delphi approach was used to screen and validate or reject these categories. The results showed that all indicators received a score higher than 0.7, thus confirming all 37 identified sub-categories by the experts. Subsequently, the fuzzy TOPSIS approach was applied to prioritize each of the sub-categories within the framework of the main categories. The results of this section also indicated that in the causal factors section (idea generation), the highest scores were related to organizational business policies and customer needs assessment. In the contextual factors section, the highest scores were related to market structure and product structure, respectively. In the intervening factors section, prioritization was given, in order, to the company's capabilities, market and stakeholders, and laws and regulations. The main categories were prioritized as including product portfolio management and quality management. The actions and interactions of the model also included process screening indicators, product value engineering, financial screening, economic screening, and after-sales services. Finally, the outcomes prioritized included initial prototyping, initial market testing, and pilot production.

Keywords: Valuation of industrial projects, mixed research, grounded theory, TOPSIS

1. Introduction

Product design, as an action, refers to the process of creating a new product to be sold to the customers of a business. Due to the absence of a universally accepted definition that can completely encompass all topics related to product design, two separate definitions are needed: the first is a definition that can directly

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introduce product design from the perspective of a product, and the second is a definition that can present the process of product design in relation to these creations. Product design, as a term, represents a set of specifications for a product, which includes general specifications: form (the aesthetic and tangible characteristics of the product or service) and function (its capabilities) in a combined and integrated manner (Chen & Bollerslev, 2017).

The product design process is a set of strategic and tactical activities that spans from idea generation to commercialization and the creation of a product design. In a systematic approach, product designers conceptualize and evaluate ideas, transforming them into new tangible products or artifacts. The role of product designers is to combine art, science, and technology with the goal of creating products that people can use. Today, the emergence of digital tools has enabled designers to communicate, visualize, analyze, and produce products in extraordinary ways, completely transforming their workflow.Designing a new product not only generates significant profit for companies but also serves as an important tool for achieving a more sustainable competitive advantage. Considering various aspects of customer desires and needs is the primary motivating factor for introducing new products or services within manufacturing or service organizations. The extent to which an organization allocates its activities to research and development of new products to outpace competitors is a matter that is linked to the current position and strategy of the organization in the marketplace (Laleh et al., 2019).

It is important to note that the desires and needs of customers are always the motivating factors for the innovation and creativity of organizations in their business processes. These factors compel organizations to invest more in their design and production processes to maintain existing customers and attract potential customers. In a world-class manufacturing environment, every customer demands efficiency, reliable quality at the lowest possible and competitive cost. To achieve this goal, engineers must conduct lifecycle business studies to decide on the optimal balance of efficiency and quality assurance for designing the best product. Nevertheless, achieving the design of new and successful products is not simple, and a small percentage of brands successfully design new products (Davies et al., 2014).

In fact, the rapid pace of technological change, intense competition, dynamic customer needs, and low demand for obsolete products have led to shorter product lifecycles. A very important point for success in the current highly turbulent environment is the organization's capability to design and produce new products. Designing new products in a rapidly changing competitive market represents a management strategy for the survival and growth of most companies. To achieve superior market performance in a highly competitive business environment, organizations are compelled to design new products utilizing their organizational resources and capabilities for proper development. However, multiple studies indicate that the failure rate in new product design has been a fundamental issue for many companies. This has raised concerns within companies regarding the design and production of new products (Davies et al., 2014).

Various studies in the 1970s showed that new products accounted for 20 percent of a company's profits, which increased to 33 percent in the 1980s. However, this figure climbed further during the 1990s, reaching 50 percent. Some research also predicts that new products accounted for more than 42 percent of company sales between 1985 and 1990. Therefore, although it was expected that the number of products introduced by these organizations would double in recent years, the newly designed products have shown a worrying downward trend and a lack of success. Recent research also indicates that the success rate in designing new products and developing them for the competitive market is less than expected (Chen et al., 2017; Nozari et al., 2022). Considering that the failure of newly designed products incurs significant costs for organizations, the necessity of planning with a competitive approach has compelled companies to implement appropriate strategies in the path of competition. A review of the literature on the design and development of new products also indicates that various factors play a role in the success of designing a new product and its successful distribution in the market (Davies et al., 2014; Rahmaty & Nozari , 2023).

Accordingly, over the years, models for designing new products have been introduced and tested in dozens of industries based on the effective factors in product design. The ambiguity and risk of uncertainty associated with these models in formulating and executing new product strategy for entering novel markets have been at an acceptable level. Therefore, companies, relying on credible models, should mitigate the risk arising from the selection and execution of new product development strategies. Thus, understanding the product design strategy models will assist policymakers and planners in companies to formulate competitive strategies with a broader perspective (Zamani et al., 2016;Ghahremani-Nahr et al., 2023).

A generic decision-making model for designing a new product, based on decisions regarding multiple features and using a combined approach, may only seem like a simple model; however, it can be considered a novel approach for introducing the important and impactful factors in the design of new products and their success in the market. Therefore, in the current research, an effort has been made to develop a framework for evaluating new industrial designs in the automotive industry, following the identification of the challenges in designing new products. Consequently, the research question is: What components and indicators does the evaluation model for new industrial designs in the automotive industry encompass?

2. Theoretical Foundations and Research Background

The Iranian automotive industry, as one of the vital sectors of the country's economy, has always been of great significance, and its development is one of the fundamental economic goals of the nation. Given the growing changes in the global automotive industry, the need for creating and evaluating new industrial projects in this sector has become an important issue. Valuating these projects is a critical matter for strategic decision-making within the industry.In this chapter, an effort has been made to address both the theoretical and empirical foundations of valuing new industrial projects in the Iranian automotive industry. The automotive industry is advancing rapidly in terms of technology and economics, and paying attention to the creation and updating of new industrial projects enhances the growth and competitiveness of automotive companies. To select and differentiate projects with high value and executable potential, there is a need for precise and scientific valuation. Therefore, the subject of valuing new industrial projects in the Iranian automotive industry has been regarded as a significant and fundamental issue, ensuring the sustainable development of this sector and increasing the country's competitive ability in global markets.In the following sections, the theoretical foundations and the importance of valuing new industrial projects will be examined in more detail. In this chapter, concepts, theoretical frameworks, and previous research will be reviewed in accordance with the research variables involved.

2.1. Introduction and Development of New Products

Clark and Fujimoto (2019) state that "the introduction and development of new products is an information- and knowledge-intensive task." Successful development of new products is made possible by integrating capabilities both upstream (design engineers) and downstream (production flow), and a company's development capabilities stem from its ability to create, distribute, and utilize knowledge throughout the derived processes. Nonaka and Takeuchi (2005) consider shared knowledge to be "one of the unique, valuable, and critical resources essential for obtaining a competitive advantage."

The introduction and development of new products typically involve a set of historically continuous and interrelated activities (Cooper et al., 2001). The effort to develop a product may not only result in a successful new product for existing customers but may also generate existing technological knowledge for potential projects (Mahajan and Wind, 2018). In this way, companies "continuously aggregate competencies for product development through a sequence of new product development activities" (wheelwright and Sasser, 2010).

2.2. Criteria for Analyzing and Discussing the Introduction and Development of New Products

The first step in defining the criteria for the introduction and development of new products is the effort to standardize the terms used for analyzing the introduction and development of new products. Much of the confusion in this area arises from the contradictory terminology used. While the subject may be the same, the terms used by different authors vary. The most commonly agreed-upon terms include "new product introduction and development model," "new product introduction and development strategy," and "new product introduction and development activities." Therefore, these terms will be used consistently throughout this paper.

	Terminology / Author	Policy deployment	NPID Model	NPID framework	NPID Process	NPID Organisation	NPID roadmap	NPID structure	NPID strategy	NPID architecture	NPID Tools	NPID Activity
1	McGrath (2004)	○	●	●	●	●	●	○	●	●	○	●
2	Terwiesch et al (1999)		●		○			○	●			●
3	Cooper (2004)	●	●	●	●	●	○		●	●	●	●
4	Kahn (2004)	●	●		●	●	○	○	●		○	●
5	Kennedy (2003)	○	●		○				●			●
6	Kucmarski (2000)	●		○	●	●		○	●	●	●	●
7	Patterson (1999)	●	●	●		●	○	●	●	●	○	●
8	Griffin et al (2002)	●	●	●	●	●	●		●	●	●	○
9	Cagan (2002)	●	●	○	●	●	●	○	●	●	●	●
10	Roseau (1999)	●	●	●	●	○	○	●	○	●	●	●
		7	9	5	7		7	2	9	7	5	9

Figure 1. Various Terms Used in Some Texts for Introducing and Developing New Products

The black boxes indicate the extensive use of terminology, while the white boxes represent the limited use of terms related to the introduction of new industrial designs. The definitions discussed in Figure 1 serve as a basis for analyzing the introduction and development of new products and how these conditions relate to one another. The combination of multiple related strategies provides a framework for the new product introduction and development model. Additionally, beneath each strategy, there are various activities such as customer feedback or knowledge management.

The new product introduction and development model: encompasses limited capacity for development within an organization. This model essentially serves as the main framework that guides the company's innovation and product development initiatives and includes a set of historically continuous and interrelated strategies.

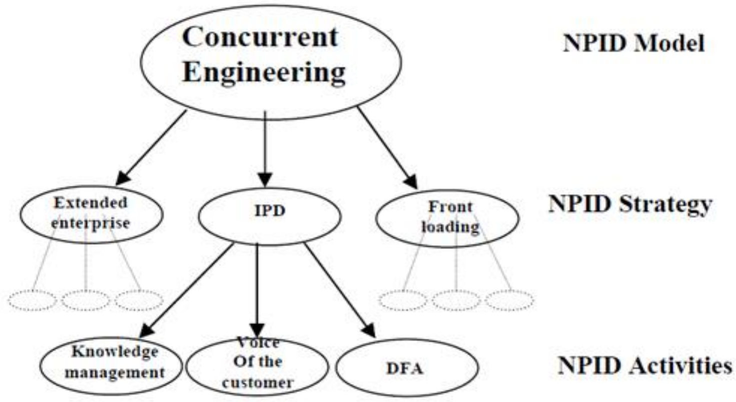

Figure 2. An Example of Strategy Creation Using the Model

New Product Introduction and Development Strategy: These are the individual strategies used for the introduction and development of new products, which together form a comprehensive model. In the example illustrated in Figure 2, strategies such as Integrated Product Development (IPD) encompass activities like customer voice, knowledge management, and Design for Assembly (DFA). A company's strategy includes individual activities and systems. The strategic plan should reflect the interpretation of market opportunities and customer desires.

Activities for New Product Introduction and Development: The activities associated with new product introduction and development involve coordinated efforts across different time frames and organizational disciplines, extending the product lifecycle.

2.3. Models of New Product Introduction and Development

Various models of new product introduction and development have been researched over the past decade, including:

1 - A Concurrent Engineering Model Based on New Product Introduction and Development (Terwiesch and LK, 2000).

2 - Stage-Gate Model (Cooper, 2013)

3 - Reaction Model (Chen, 2005)

4 - Pre-Preparation Model (Clark et al., 2019)

The Concurrent Engineering Model and the Stage-Gate Model will be discussed in detail because they closely align with two models used in the literature as well as in the industry. These models are primarily analyzed in the testing sector. The Pre-Preparation Model will be briefly examined at the end of this section. As shown in Figure 2, the Concurrent Engineering Model and the Stage-Gate Model are in contrast to one another. The tasks executed concurrently in the Concurrent Engineering Model are set against the structured activities and regular project status updates in the Stage-Gate Model. The reality is that the strategies and individual activities in the actual models are very similar to one another. In order to create a different perspective and assess the practicality of the various existing models, different levels of complexity will be examined against the mentioned criteria.

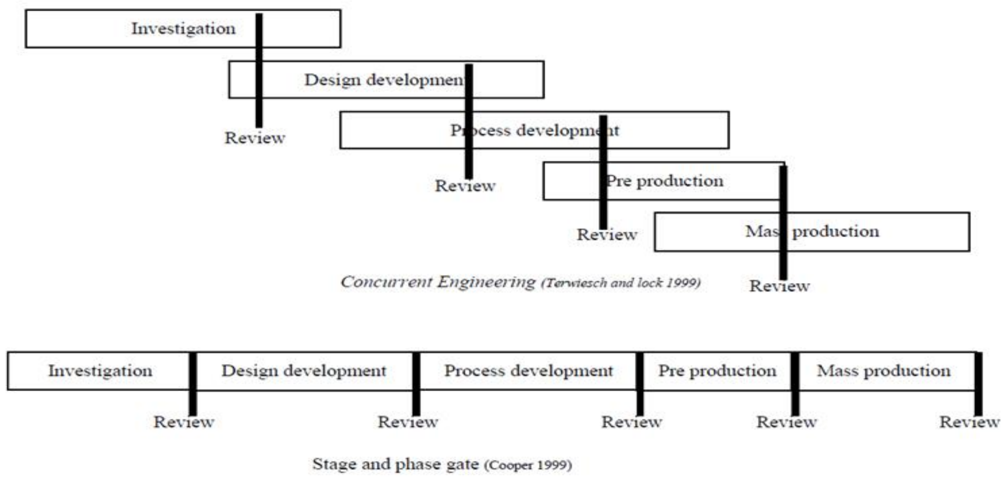

Figure 3. Concurrent Engineering Model Based on New Product Introduction and Development (Trott and Al-Khal, 2000) and the Stage-Gate Model (Cooper, 2013)

2.3.1. Concurrent Engineering Model Based on New Product Introduction and Development (CE)

Concurrent Engineering (CE) is a product development approach that increases productivity and can lead to significant improvements in new designs. However, this model heavily relies on the quality of information, interpretation, execution, and implementation. CE is defined as a "nonlinear product or project approach in which all activities of new product introduction and development operate simultaneously" (Parsaei & Williams, 2001). In this model, the product and process are heavily coordinated to achieve optimal alignment of requirements for cost-effectiveness, quality, and delivery. The relationship between the product and the process is of utmost importance. Product lifecycle engineering will assess the impact of future enhancements or recycling of the product, while lean manufacturing serves as a benchmark for the product and process by eliminating unnecessary (and pointless) stages. The automotive industry is at the forefront in many aspects to reduce costs while remaining competitive. Terwiesch and Loch (2000) discussed that there are many aspects to consider in the development of a product. These include final cost, manufacturability, safety, packaging, and recyclability. These aspects represent different phases in the product lifecycle. In traditional design methods, the product is evaluated after the completion of each phase. However, Rosenthal (2012) points out that "downstream aspects are affected by decisions made during the design phase." Consequently, these aspects must be considered during the design phase, which is very challenging in upper-level silo reviews.

Smith and Reinerssen (2018) demonstrate that automakers seeking to take on design responsibilities must significantly enhance their ability to effectively execute concurrent engineering in the early stages and often throughout the production process. Figure 3 shows the Concurrent Engineering (CE) model defined by Trovitch and colleagues (2000). Activities in this model progress simultaneously and are completed concurrently, thus reducing project time and costs. In this model, the single strategy can be subdivided into activities of new product introduction and development that are crucial for that phase of the new product introduction and development process. For example, completing the FMEA (Failure Mode and Effects Analysis) plan before the design approval of the product is essential to reduce costs, lead time, and process complexities.

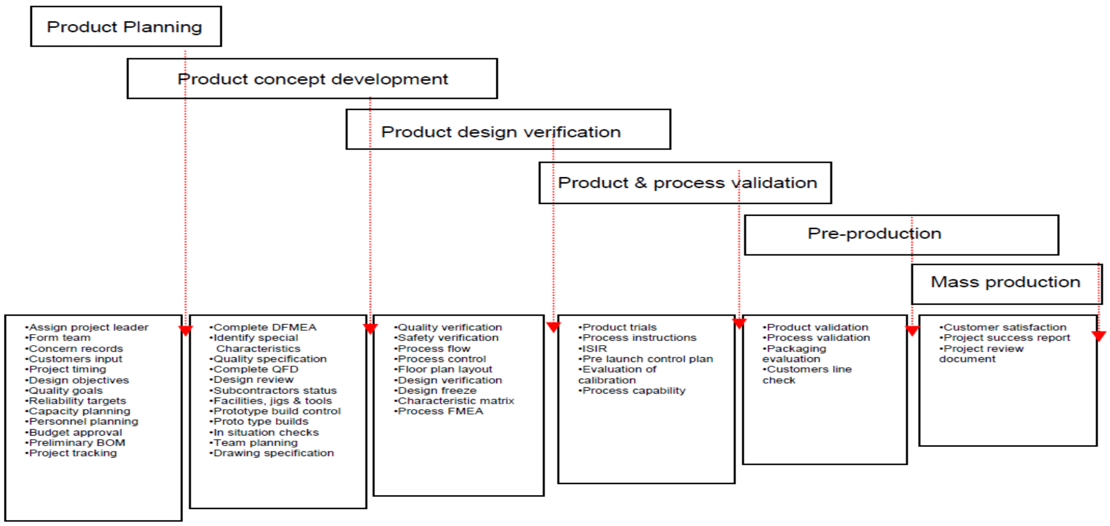

Figure 4. Concurrent Engineering Model for New Product Introduction and Development Based on New Product Introduction and Development (Travić et al., 2000)

Many studies have been conducted in this area, consistent with the various activities involved in concurrent engineering. However, they have less clarity regarding their role in the introduction and development of new products (Clark and Fujimoto, 2019; Highsmith, 2004; Ernst, 2002; Smith and Reinertsen, 2018). The challenges of Concurrent Engineering (CE) from a global perspective include:

1. Managing Large, Multifunctional Project Teams: Project team management plays a critical role in the introduction and development of new products and can result in multiple project managers located in different places with varying inclinations (Highsmith, 2004).

2. Overlapping Activities: Dependency and trust among dispersed team members.

3. Direct Communication through Teamwork: Distance and time differences make this nearly impossible, necessitating strong support from Information Technology (IT).

4. Rich, Detailed Information Transfer: This allows for the integration of upstream and downstream activities, making production across distances challenging, and requiring strong technical support.

5. Direction and Decisions that Consider Downstream Activities: Specific assumptions, such as manufacturing early in the project, have a direct impact on downstream segments.

6. Prepared Information: Initial team information may not be essential for a downstream department like production, and vice versa is equally true.

7. Problem Solving, Review, and Response between Product and Process Phases: This activity is often completely overlooked in most new product introduction and development projects.

8. Integrated Supply Management with Early Involvement: A supplier base entails more complexities of communications and currency fluctuations that are not understood in local new product introduction and development projects.

9. Integration of Development Tools for Customer and Supplier Communication: Global new product introduction and development can often lack integration of supplier or customer communications and thus relies on the development team for this activity.

10. Project Phase Review Focused on Senior Management: The internal management team for new product introduction and development may change throughout various project phases, making it difficult to maintain focus due to continuous membership changes.

11. Strategic Intergenerational Product and Platform Management.

12. Technical Evaluation, Team-Based Recognition Systems, and Promotions: These become impossible in the evaluation and reward processes of new product introduction and development teams.

The challenges of introducing and developing new products involve successfully negotiating these activities with teams that differ in location, distance, time, language, and culture.

2.3.2. Stage-Gate Phase Model

The Stage-Gate phase model was described by Cooper in the 1980s and further developed by Cooper and his colleagues (2001) as a framework for introducing and developing new product projects. The stages of this model are separated by gates, which serve as checkpoints to ensure that the previous phase has been completed before moving on to the next one. Managers can use this model to review the progress of a

project at various stages of development and confirm that all objectives have been achieved before advancing to the next phase.

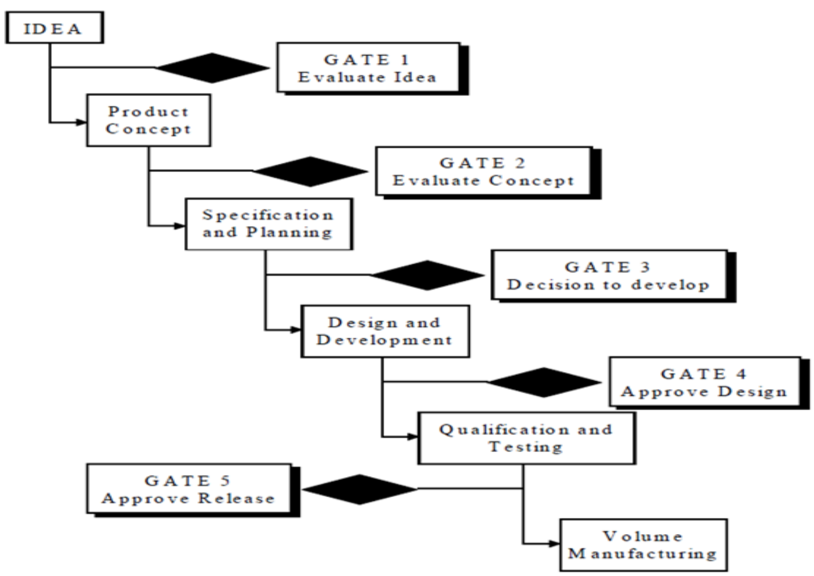

Figure 5. Cooper's Stage-Gate Model (2013)

Different authors have introduced and developed the phase-gate process under various names, describing new product development as a staged process (Kessler and Bierly, 2002) as illustrated in the figure. Key points mentioned are:

- Screening products in the early stages is less expensive.

- Each control stage leads to product improvement and increases the success rate.

Booz, Allen and Hamilton (2001) examined the Stage-Gate model process as a greater contribution to product success. Figure 6 shows the project stages similarly described by Boz, Buttrick (2001), and Cooper

(2013), ranging from a seven-phase and gate introduction to a five-phase and gate introduction (Toyota uses 11 phases and multiple gates, while Land Rover has 14 stages, typically divided into two distinct and deliberate gate approaches). The stages commonly mentioned by various authors include: 1) Idea Generation, 2) Development, and 3) Commercialization.

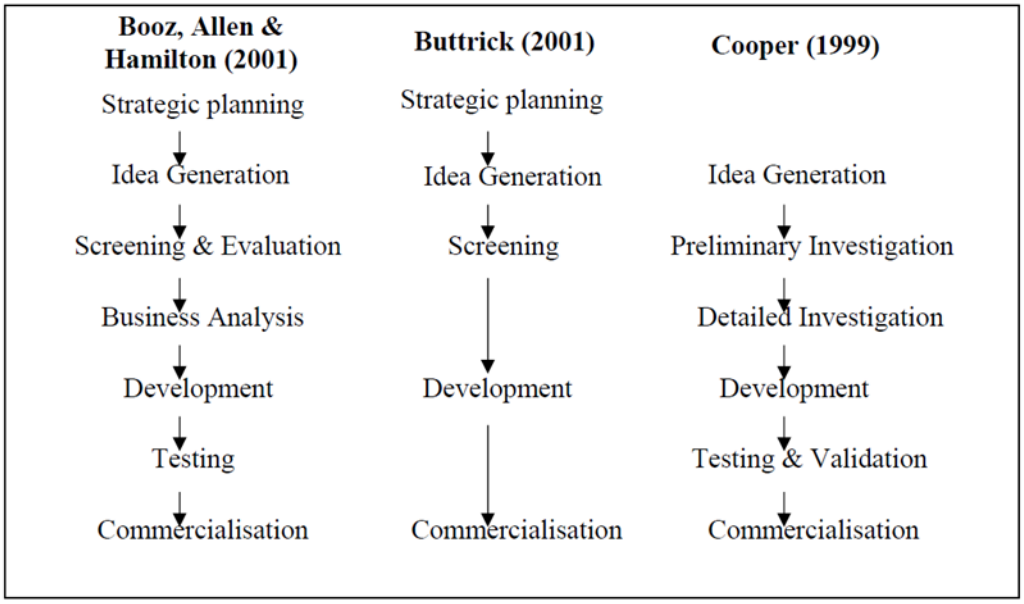

Figure 6. Stages of the New Product Introduction and Development Process by Booz, Allen, and Hamilton (2001), Bouchard (2001), and Cooper (2013)"

Gates (Figure 6) act as milestones and are designed to ensure that the activities in the previous phase are completed before moving on to the next phase. Phase-gate reviews should be conducted in line with the level of risk in the project, rather than the amount of time between reviews (Cooper, 2013).

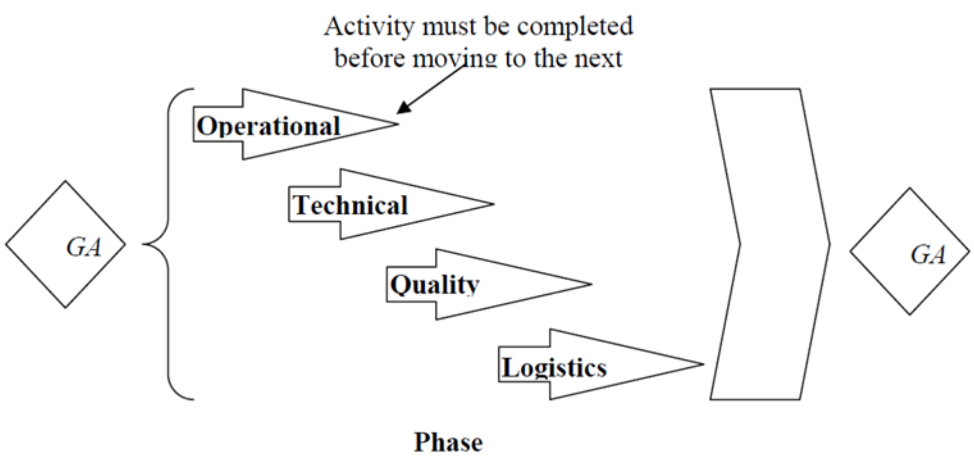

Figure 7. Phase and Stage Gate Model Gates

The phase-gate model process provides both a conceptual and operational roadmap for moving a new product from idea to launch. This approach is a widely adopted product development process that divides the effort into distinct stages sequenced by management decision gates. Cross-functional teams must successfully complete a set of related cross-functional tasks at each stage before obtaining management approval to proceed to the next stage of product development.

The main advantage of this model is the identification of clear points at which unattainable projects can be recognized and subsequently stopped or dissolved (Cooper, 2013). These "go/kill" gates ensure that projects are terminated at the earliest (and most cost-effective) opportunity, resulting in savings in both time and cost. Cooper discusses the use of this model as a risk management tool, suggesting that the greater the risk, the closer adherence to the model becomes. During the examination of this model, it was found that despite its advantages, the model still requires improvement, as not all studies agree with the phase-gate approach.

Muffatto and Roveda (2022) argue that the control systems of the phase-gate model are overly cumbersome, and most companies prefer to use a less formal system, especially at the local level for global projects. Dinsmore (2020) suggests that structured gates can be limiting; however, they allow team members to focus on the work at hand rather than on what needs to be done in the future. From the perspective of Mahajan and Wind (2018), the traditional stage-gate process becomes cumbersome and inappropriate in today's complex, uncertain, nonlinear, and intertwined market environment. Carter and Baker (2012) suggest that some companies complicate the process, and the stages should be kept as short as possible; otherwise, problems may compound, and the opportunity for quick resolution with management intervention may be lost. Kerzner (2005) identifies that the stage-gate process allows for order and senior management involvement through a series of stop, go, and recycle points, which often limits project flow rather than acting as a filter, which can become blockers. Other models for introducing and developing new products, particularly concerning global aspects, are briefly discussed in this section.

2.3.3. Other Models for Introducing and Developing New Products

The responsive model for introducing and developing new products involves expanding technological, organizational, and human resources to adapt to unforeseen changes in how these products are launched in the global economy. The main challenge in the global introduction and development of new products is the integration of excess resources, rather than the technologies, organizations, and individuals that pose the greatest challenges – instead of focusing on the technologies they employ. Poor communication and project mismanagement are two common issues. Many stages of the responsive model occur before production is involved, and careful examination of these stages can be understood as strategic information processing or as the connection between effective strategy and effective responsive production (Joseph, 2018; Dean, 2016; Chen, 2005).

A notable model that has emerged in recent literature on new product introduction and development is the pre-preparation model. The activities of problem-solving and knowledge gathering known as "pre-preparation" occur as early as possible in order to reduce uncertainty and address issues before they arise. This allows for faster and more efficient project execution with fewer design iterations and delays.

Cooper (2013) divides the pre-preparation model into four stages: idea creation, initial screening, early evaluation, and concept evaluation, emphasizing the importance of technical and market-related activities. Khurana and Rosenthal (2018) define pre-preparation as "the formulation and communication of product strategy, identifying and assessing opportunities, generating ideas, defining the product, project planning, and operational reviews."

3. Research Results

At this stage, using the grounded theory approach, the opinions of experts were documented and coded, and the results related to this phase are presented below. In the current research, grounded theory was used to collect data and information for qualitative analysis. This paper utilizes the views of experts, managers, and stakeholders in the country's automotive industry. The sampling method in this section of the present research is purposive sampling. After conducting 11 interviews, it was observed that the main and subfactors were repeated in the interviews, and the responses followed a repetitive trend. However, to ensure greater validity, 4 additional interviews were conducted, and the sample was confirmed with 15 individuals, concluding the interviewing process as theoretical saturation was reached.The researcher guided all the interviews. This approach allowed the researcher to utilize information obtained from previous interviews in subsequent ones. Thus, after each interview, ambiguous points or weaknesses in the patterns and categories were identified, and the next participant was selected based on the required expertise to clarify the ambiguities. Data collection continued until the point of theoretical saturation of the categories, or more explicitly, until it became impossible to obtain any new data. After transcribing the interviews, coding was conducted. Additionally, the strategy for validating the results in this study was confirmed through the partial least squares method. Based on this, after implementing the interviews, the narratives were coded at three levels: initial coding, axial coding, and selective coding. The initial coding stage is considered open and general. Following this type of coding, secondary coding must be performed, in which the initial codes, due to their large number, are grouped into similar categories or secondary codes, eventually leading to axial coding.

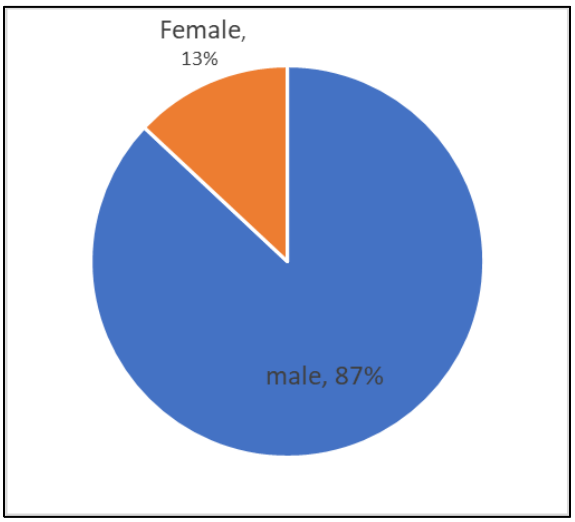

Figure 1. Frequency of Interviewees by Gender

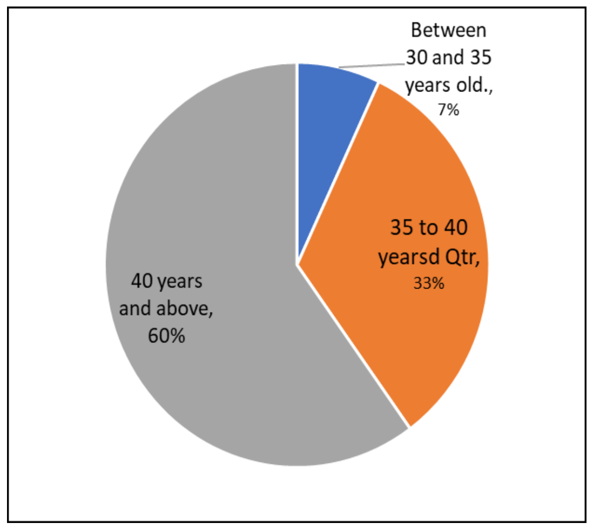

Figure 2-Frequency of interviewees by age

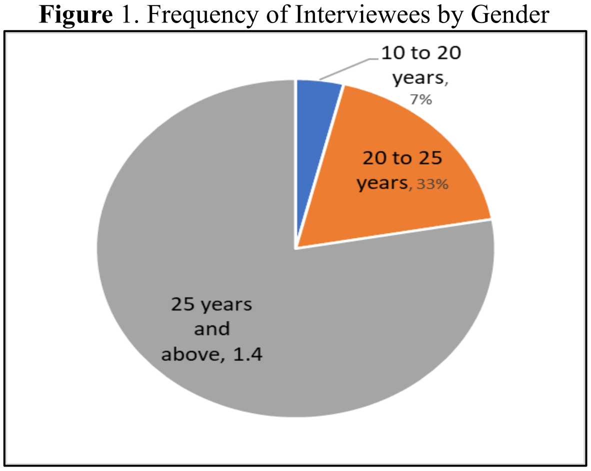

Figure 3 - Frequency of interviewees by work experience

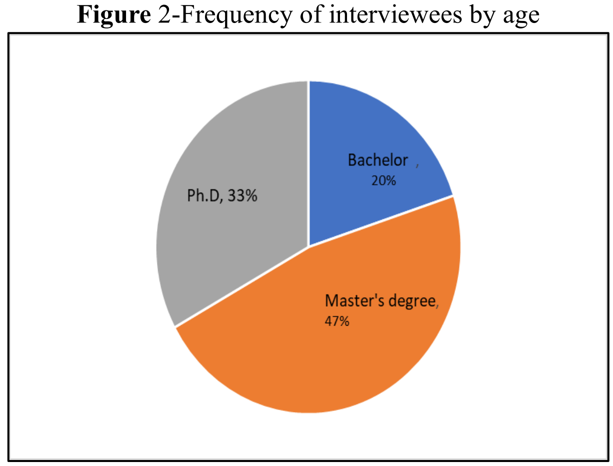

Figure 4 - Frequency of Interviewees by Education

3.1. Analysis of Grounded Theory Coding

In this research, the Strauss and Corbin approach of grounded theory was used to identify the dimensions and components of the model for evaluating new industrial designs in the automotive industry. It is noteworthy that the data collection and analysis process in this research method was carried out through continuous and comparative coding in a back-and-forth manner simultaneously. Data collection continued until the researcher reached saturation in the data, leading to the relevant concepts related to the model for evaluating new industrial designs in the automotive industry, as proposed by various interviewees, being categorized into repeatable patterns. This section discusses open coding, axial coding, and selective coding.

Open coding is part of the analysis that is conducted through careful examination of the data, involving the naming and classification of data. To accurately classify concepts into categories, each concept must be labeled after separation, and raw data should be conceptualized by carefully examining the text of the interviews and contextual notes. The data collected from the interviewees are coded to facilitate the identification of similarities and differences. In this stage, the text of each interview was read, and a code was assigned to each key point.When the data was opened up and concepts emerged from within it, the researcher looked for instances that could help categorize these concepts into categories. According to the viewpoint of Strauss and Corbin (1998), some concepts can be classified into categories that possess a higher level of abstraction compared to those concepts (Strauss and Corbin, 1998). With the help of categories, ongoing events can be described; thus, in the next step, categories were identified by bringing together corresponding concepts, which essentially form a combination of several concepts. In this research, a total of 37 concepts and 6 subcategories were identified.

Table 1. Subcategories Identified in the Research

Row	Subcategory	Concepts
1	Ideation	Customer Needs Assessment
2		Competitor Analysis
3		Engineering Requirements
4		R&D (Research and Development)
5		Organizational Business Policies
6		New Product Development Knowledge Base
7	Contextual Conditions	Financial Analysis and Provisioning
8		Comprehensive Feasibility of Production
9		Market Structure
10		Product Structure
11		Quality Management
12		Concurrent Engineering
13	Technical and Market Assessment	Benchmarking
14		Voice of the Customer
15		DFMEA (Design Failure Mode and Effects Analysis)
16		M&I (Mergers and Acquisitions)
17		Product Portfolio Management
18		Product Supply Chain Management
19		Analysis and Review
20		Design Failure Effects and Criticality Analysis
21		Maintenance and Monitoring

22	Intervening Conditions	Lead Time
23		Environmental-Green
24		Market and Stakeholders
25		Company Capabilities
26		Regulations and Statutes
27	Proposal Screening	Financial Screening
28		Process Screening
29		Product Value Engineering
30		Economic Screening
31		After-Sales Service
32	Proposal Selection	Prototyping
33		Initial Market Testing
34		Pilot Production
35		Post-Launch Monitoring
36		Market Positioning
37		Social Value and Individual Approach

Source: Current Research

3.1.1. Axial Coding

Axial coding is the process of relating categories to subcategories and linking categories at the level of characteristics and dimensions. It is called axial coding because the coding is centered around a core category (Lee, 2001). In this stage, categories are organized and positioned based on the characteristics and dimensions derived from open coding, allowing for the understanding of processes related to relationships (Lee, 2001). Strauss discusses several main actions in the axial coding stage, which are indicated in the following list (Strauss, 1987).

Core Category: The core category is a central idea, thought, incident, event, or occurrence that guides the flow of actions and reactions towards it in order to manage, control, or respond to it. The core category is associated with the central question: what do the data indicate? The core category represents a conceptual title or label for the framework or scheme being developed.

Causal Conditions: Causal conditions are the events and occurrences that lead to the emergence or expansion of the phenomenon in question.

Contextual Conditions: Contextual conditions are special conditions that influence the strategy. They reflect a set of specific circumstances in which the strategies of action and reaction occur.

Intervening Conditions: Intervening conditions are structural conditions that pertain to the phenomenon in question and affect strategies of action and reaction. They constrain or facilitate strategies within a specific context.

Strategies: Strategies are specific actions or interactions that arise from the main phenomenon. These strategies are based on actions and reactions intended to control, manage, and respond to the phenomenon in question. Strategies are purposeful and are carried out for specific reasons. At the same time, they may be implemented for goals unrelated to the phenomenon but will nevertheless have implications for it.

Outcomes: Outcomes include the results that emerge as a result of the strategies. They are derived from actions and reactions and cannot always be predicted. They are not necessarily the same as what individuals intended. Outcomes may manifest as incidents or events, can have a negative aspect, may be real or implicit, and can occur in the present or the future. Additionally, what is considered an outcome at one point in time may become part of the conditions and factors at another time.

3.1.2. Selective Coding

In open and axial coding, a model for evaluating new industrial designs in the automotive industry has been developed. This model includes prior (causal) conditions, formulation of contextual conditions, intervening conditions, implementation of policies, strategies, and evaluation of policies. Selective coding takes the results of the previous coding steps, selects the main category, and systematically relates it to other categories, providing validation for the connections and further developing the categories that require refinement (Strauss and Corbin, 1990). Selective coding begins based on the identified relationships between categories and subcategories in open and axial coding. After preparing the paradigm model to enhance the model's credibility, the paradigm model was presented to experts who were familiar with the evaluation of new industrial designs in the automotive industry and were well-acquainted with grounded theory methodology. These experts were asked to provide their feedback on the model development process and the final model; most of them approved the model and some had corrective comments that were implemented in a back-and-forth process, and their final opinions were received. Figure (8) illustrates the final model of the research in the qualitative section.

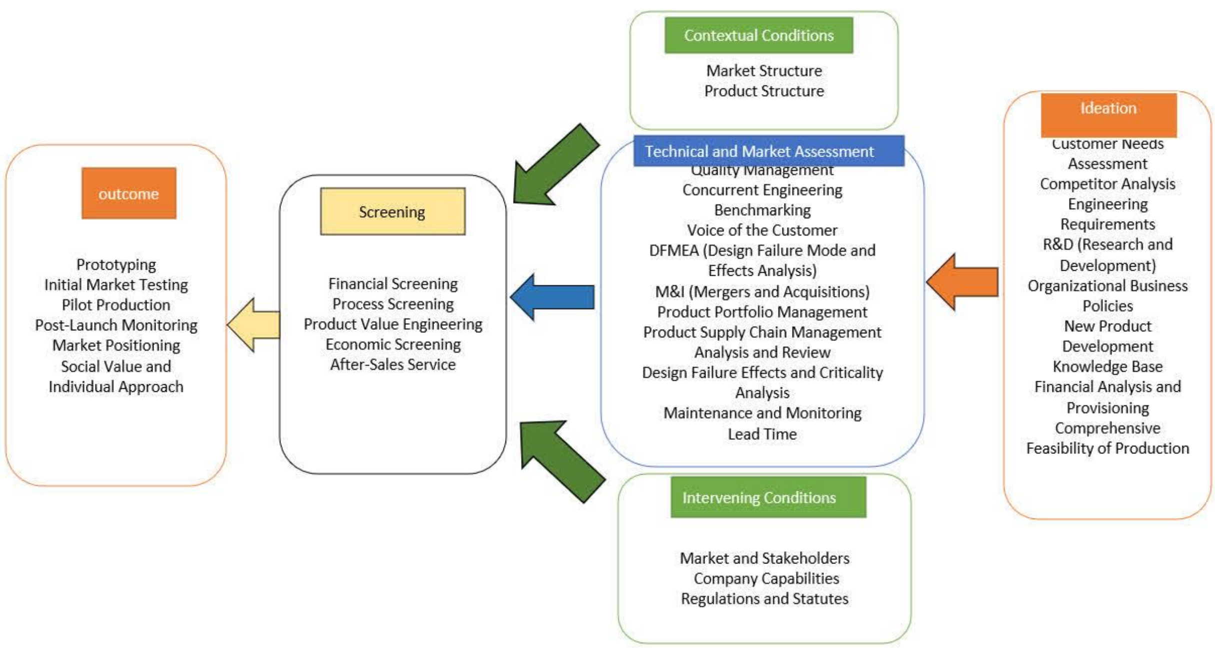

Figure 8. Conceptual model of research

Therefore, based on the narrative statement, the components obtained through the paradigms of axial and selective coding can be expressed in the form of the above model.

3.2. Quantitative Phase of the Research

The quantitative phase of the present research consists of two stages utilizing fuzzy Delphi and TOPSIS approaches. The results of each stage are presented below: In the first step, screening and identifying the final indicators for evaluating new industrial projects in the automotive industry were carried out. Based on the literature of the research and the specialized interviews conducted, a total of 37 concepts have been identified. To screen the indicators and identify the final ones, the fuzzy Delphi approach was employed. Expert opinions were utilized to assess the importance of the indicators in the qualitative phase of the research. Although experts draw on their competencies and mental capabilities to make comparisons, it is important to note that the traditional process of quantifying individual viewpoints does not fully reflect human thought processes. In other words, the use of fuzzy sets aligns more closely with the linguistic and sometimes vague explanations of humans, and thus, it is preferable to employ fuzzy sets (utilizing fuzzy numbers) for long-term predictions and decision-making in the real world (Karami et al., 2009). In this study, triangular fuzzy numbers were also used for fuzzifying the experts' viewpoints. The experts' opinions regarding the importance of each indicator were collected using a 7-degree fuzzy spectrum, and the results are presented in the table below.

Table 2. Results of Indicator Screening

Result	**Definitive Value**	**Indicators**	**Result**	**Definitive Value**	**Indicators**
Accepted	0.835	Design Failure Modes and Effects	Accepted	0.842	Customer Needs Assessment
Accepted	0.751	Maintenance and Monitoring	Accepted	0.878	Competitor Analysis
Accepted	0.713	Lead Time	Accepted	0.777	Engineering Requirements
Accepted	0.771	Environmental-Green	Accepted	0.756	R&D
Accepted	0.795	Market and Stakeholders	Accepted	0.767	Organizational Business Policies
Accepted	0.883	Company | Capabilities	Accepted	0.726	New Product Development Knowledge Base
Accepted	0.842	Regulations and Statutes	Accepted	0.757	Financial Analysis and Provisioning
Accepted	0.784	Financial Screening	Accepted	0.790	Comprehensive Feasibility of Production
Accepted	0.797	Process Screening	Accepted	0.921	Market Structure
Accepted	0.792	Product Value Engineering	Accepted	0.712	Product Structure
Accepted	0.764	Economic screening	Accepted	0.716	Quality Management
Accepted	0.814	After-sales Service	Accepted	0.844	Concurrent Engineering
Accepted	0.756	Prototyping	Accepted	0.776	Benchmarking
Accepted	0.923	Initial Market Testing	Accepted	0.858	Voice of the customer

Accepted	0.715	Trial Production	Accepted	0.936	DFMEA
Accepted	0.836	Post-Launch Monitoring	Accepted	0.718	M&I
Accepted	0.814	Market Position	Accepted	0.936	Portfolio Management
Accepted	0.801	Social Value and Individual Approach	Accepted	0.921	Product Supply Chain Management
			Accepted	0.873	Analysis

All those with a score higher than 0.7.

3.3. Results of Prioritizing Indicators Using the TOPSIS Approach

In this section, Table (3) presents the results obtained from the TOPSIS method, along with the ranking and weighting of indicators using the entropy method.

Table 3. Ranking of Indicators Related to Each Main Category

Sub-Category	Rating	Topsis	Concepts
Ideation	2	0.69	Customer Needs Analysis
	3	0.569	Competitor Analysis
	8	0.222	Engineering Requirements
	5	0.459	Research and Development (R&D)
	1	0.873	Organizational Business Policies
	7	0.258	Knowledge Base for New Product Development
	4	0.471	Financial Analysis and Provision
	6	0.455	Comprehensive Feasibility Study for Production
Contextual Conditions	1	0.131	Market Structure
	2	0.113	Product Structure
Technical and Market Assessment	3	0.258	Quality Management
	5	0.206	Concurrent Engineering
	10	0.087	Benchmarking
	13	0.019	Voice of the Customer
	6	0.174	Failure Mode and Effects Analysis (FMEA)
	8	0.132	M&I (Mergers and Acquisitions)
	1	0.697	Product Portfolio Management
	3	0.280	Supply Chain Management
	4	0.231	Analysis and Review
	7	0.135	Design Failure Effects and Analysis
	11	0.037	Maintenance and Monitoring
	9	0.109	Lead Time
	12	0.022	Environmental-Green Considerations
Intervention Conditions	2	0.447	Market and Stakeholders
	1	0.592	Company Capabilities
	3	0.214	Laws and Regulations

Project Screening	3	0.352	Financial Screening
	1	0.701	Process Screening
	2	0.392	Product Value Engineering
	4	0.288	Economic Screening
	5	0.277	After-Sales Services
Project Selection	1	0.736	Prototyping
	2	0.652	Initial Market Testing
	3	0.635	Pilot Production
	5	0.519	Post-Launch Monitoring
	4	0.559	Market Position
	6	0.483	Social Value and Individual Approaches

Based on the approval of the research model, the following presents the stages for introducing and evaluating an industrial project according to the developed model:

Table 4. Stages of Introduction and Valuation of a New Industrial Project

Row	Description	Step
	Introduction of a New Industrial Design for Market Entry	
1	The ideation stage in the valuation of new industrial projects within the automotive industry is the phase where new ideas and designs for development and production are examined and evaluated. In this stage, new ideas and plans are reviewed to identify and assess their value and potential for becoming marketable products and services.	Ideation
2	In this phase, market evaluation and analysis of customer needs and demands are conducted. This includes examining competitors, analyzing market trends, understanding customer needs, and evaluating the strengths and weaknesses of the market.	Market Research and Analysis
3	In this stage, an assessment of existing and new technologies is carried out. This includes reviewing new technologies and evaluating the technical and functional capabilities of industrial designs	Technology Assessment
4	In this phase, the financial aspects of the projects are evaluated. This encompasses an analysis of development and production costs, forecasting revenues and profitability, estimating production and distribution costs, as well as a profitability analysis of the project	Financial Review
5	During this stage, the technical and functional aspects of the projects are assessed. This includes evaluating production capabilities, quality, maintainability and repair, safety, and environmental concerns of the product.	Technical Analysis
6	In this phase, compliance with the laws, regulations, and standards related to the automotive industry is evaluated. This includes ensuring adherence to safety, environmental, and relevant regulatory standards.	Legal and Regulatory Review
7	In this stage, risks associated with the projects are assessed. This involves evaluating technical, financial, marketing, and legal risks.	Risk Assessment
8	Finally, based on the results of the previous evaluations, decisions regarding the continuation or discontinuation of the projects are made. In this phase, management and strategic decisions regarding the production and operationalization of the projects are undertaken..	Decision Making
	Pricing of New Industrial Designs in the Automotive Industry of Iran	
9		Cost Analysis

	At this stage, the costs associated with the development and production of new designs are examined. This includes an analysis of research and development costs, production costs, distribution costs, and management costs.	
10	At this stage, the target market and customer demand for the new designs are investigated. This includes analyzing customer needs, market trends, examining competitors, and analyzing factors influencing the market.	Market Analysis
11	At this stage, the valuation strategy for the new designs is determined. This includes defining the valuation objective, identifying the strengths and weaknesses of the design, determining the extent of costs, analyzing competitors' prices, and assessing the relationship between price and demand.	Determining Valuation Strategy
12	At this stage, the final value for the new designs is established. This includes balancing costs and demand, analyzing competitors' pricing strategies, determining the desired profit margin, and examining competitors' pricing.	Determining Final Value
13	At this stage, adjustments to value in the Iranian market for the designs are made. This includes analyzing the laws and regulations related to valuation in the Iranian market, determining the value change strategy, setting discount policies, and determining methods for adjusting value in response to market changes.	Setting Market Value
14	At this stage, the impacts of valuation on sales, profitability, and market acceptance of the designs are evaluated. This includes price sensitivity analysis, competitive impact analysis, and analysis of the impacts of pricing regulations.	Assessing Valuation Impacts
15	At this stage, the valuation strategy over time for the designs is determined. This includes establishing a pricing change strategy in response to market changes, setting discount policies, and determining methods for price adjustment over time.	Determining Valuation Strategy Over Time

4. Conclusion and Recommendations

The valuation model for new industrial designs in the automotive industry is of significant importance as it aids in the effective analysis and assessment of innovative designs. This model enables the identification of potential costs and benefits associated with each design, ultimately facilitating better decision-making regarding investments and feasibility. Furthermore, the aforementioned model can address the risks associated with new industrial designs, allowing companies to devise better strategies for mitigating these risks. Additionally, it contributes to fostering innovation and competitiveness in the market, thereby making it easier to attract investors. Ultimately, focusing on the valuation of designs can guide companies towards more sustainable and responsible development, particularly in an era where attention to environmental and social issues is increasingly vital.

Based on the findings, several practical recommendations can be proposed:

1. Research and Development: Investing in research and development for producing new industrial designs can enhance value and innovation in the automotive industry. It is recommended to focus on advanced technologies to improve vehicle performance, reduce fuel consumption, and minimize emissions.

2. Environmental Sustainability: Considering environmental issues and assisting in reducing air pollution and waste production can aid in the valuation of new industrial designs. This includes the use of green technologies, electric and hybrid vehicles, recyclable materials, and designing fuel-efficient vehicles.

3. Safety Enhancement: Improving vehicle safety and reducing traffic accidents can contribute to the valuation of new industrial designs. It is advised to focus on intelligent safety systems, autonomous driving technologies, and accident warning systems.

4. Innovation in Design and Utilization of Smart Connections and IoT: Enhancing efficiency, communication, and user experience in vehicles through innovative designs and smart connections and the Internet of Things (IoT).

5. Market Needs Assessment: Analyzing customer needs and preferences during the design and production of new vehicles can support effective valuation. This includes improving customer service, enhancing comfort and communication features inside the vehicle, and offering satisfactory after-sales services. It is important to consider various criteria such as economic, technical, environmental, and social factors in valuing new industrial designs, aiming to select designs that achieve the best balance among these criteria.

6. Artificial Intelligence and Related Technologies: Utilizing artificial intelligence, machine learning, and related technologies can assist in the valuation of new industrial designs in the automotive industry. This includes employing smart systems to enhance vehicle control and performance, advanced navigation and guidance systems, and leveraging big data for analyzing and predicting vehicle performance.

7. Collaboration with Strategic Partners: Collaborating with strategic partners such as universities, research centers, and technology companies can support the valuation of new industrial designs. This collaboration can lead to the sharing of knowledge, resources, and experiences, driving improvement and innovation in designs.

8. Compliance with Regulations: When valuing new industrial designs, it is essential to consider regulations related to the automotive industry. This includes safety standards, emissions regulations, fuel consumption, and technical standards.

9. Process Improvement and Productivity: Enhancing processes and productivity in the production of vehicles and parts can contribute to increasing the value of new industrial designs. It is recommended to focus on utilizing advanced technologies in manufacturing, optimizing supply chains, and reducing waste.

10. Price Competitiveness: Finally, in valuing new industrial designs, attention must be paid to price competitiveness in the automotive market. Considering production costs, competitive pricing, and competing effectively with other manufacturers can facilitate effective valuation.

References

Booz Allen and Hamilton (2001),“New product Management” Journal of Engineering.

Buttrick R (2001) “The interactive project workout, reap rewards from all your business projects”, Financial Times, Prentice Hall

Chen .T., T. Bollerslev. (2017). A fuzzy back propagation network for output time .prediction in a wafer fab, Applied Soft Computing. 211-222

Clark K.B. and Fujimoto T. (2019) “Product Development Performance Strategy Organisation and Management in the World of the Auto Industry”, Boston Mass, Harvard Business School Press.

Cooper R.G, Edgett S.J. and Kleinschmidt E.J, (2001) “Portfolio Management for new product development: results of an industry practice study”, Research and Development Management, Vol 31n (4).
Davies E and Spekman R (2003) “Introduction to the Extended Enterprise: Gaining Competitive Advantage through Collaborative Supply Chains” Financial Times Prentice Hall.
Dean J and James W, (2016). “7”. Strategic Management Journal 17: 459-480.
Dinsmore P. (2020) “From project management to enterprise project management” Project Manager, Vol 19 No 2.
Ernst H (2002) “Success factors of new product development: a review of the empirical literature” International Journal of management Reviews, Volume 4, Issue 4, pp 1 – 40.
Ghahremani-Nahr, J., Nozari, H., & Aliahmadi, A. (2023). Contract Design for Return Products in a Cooperative Closed-Loop Supply Chain. Global Business Review, 09721509221148892.
Highsmith J (2004) “The agile revolution” Addison-Wesley publishing, pp 18-27
Joseph, A. T. (2018). "Formulation of Manufacturing Strategy." International Journal of Advanced Manufacturing technology 15(522-535).
Kerzner H, (2005) “Project Management, a systems approach to planning, scheduling and controlling”, John Wiley.
Kessler E. H., Chakrabarti A.K (2002) “Speeding up the pace of new product development”. Journal of Product Innovation Management 16:231-247.
Khurana A. and Rosentahl S.R. (2018) “Towards Holistic "Front Ends" in New Product Development”. Journal of Product Innovation Management 15: 57-74.
Laleh, Sina; Shadnoush, Nasrullah; and Talouyi-Esfahani, Abbas (2019). "Designing a Model for Measuring Technological Capabilities in the Economic-Financial Valuation Process of R&D Project Costs for Knowledge-Based Companies Contemplating Entry into the Stock Exchange." Financial Engineering and Securities Management, 10(40), pp. 201-220.
Mahajan V. & Wind J. (2018) “New Product Models: Practice, Shortcomings and Desired Improvements”, Journal of Product Innovation Management, 9, pp. 128-139.
Muffatto M. and Roveda M. (2022) ”Product architecture and platforms: a conceptual framework”, Int. J. Technology Management, Vol. 24, No. 1, pp.1-16.
Nonaka I. (2005) “Redundant Overlapping Organisation, A Japanese Approach to Managing the Innovation Process”, California Management Review.
Nozari, H., Ghahremani-Nahr, J., Fallah, M., & Szmelter-Jarosz, A. (2022). Assessment of cyber risks in an IoT-based supply chain using a fuzzy decision-making method. International Journal of Innovation in Management, Economics and Social Sciences, 2(1).
Parsaei H.R and Williams G.S (2001) “Concurrent Engineering, Contemporary issues and modern design tools”, Chapman and Hall, New York.
Rahmaty, M., & Nozari, H. (2023). Optimization of the hierarchical supply chain in the pharmaceutical industry. Edelweiss Applied Science and Technology, 7(2), 104-123.
Rosenthal S.R. (2012) “Effective product design and development. How to cut lead time and increase the customer satisfaction” Homeward ILL, Business One, Irvin.
Smith P.G. and Donald G.R (2018) “Developing Products in Half the Time”, 2E, John Wiley & Sons, Inc.
Strauss, A., & Corbin, J. (1998). Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. Thousand Oaks, CA: Sage Publications, Inc.
Terwiesch. C, and Loch.C (2000) “Product Development and Concurrent Engineering”, Encyclopaedia Of Operations Management.
Wheelwright S.C. and Sasser W.R (2010) “The New Product Development Map”, Harvard Business Review, May-June, 112-125.
Zamani, Fatemeh; Marvati, Ali; and Mirghafouri, Habibollah (2016). "Presenting a Combined Model of Data Envelopment Analysis and Artificial Neural Networks for Evaluating and Predicting the Performance of Bank Branches." The Third National Conference on Accounting and Management, pp. 1-17.